What we claim is:

1. A liquid volume-flow meter comprising

   a. a measuring chamber formed as a pipe having a wall of transparent material;

   b. an optical velocity array for measuring the speed of liquid flowing within the measuring chamber; and

   c. an optical area sensor for measuring the area within the measuring chamber occupied by liquid flowing within the measuring chamber;

   in which the optical area sensor comprises a plurality of arrays including a backscatter reflection array to estimate the height of liquid within the measuring chamber and at least one further correction array to correct the estimation made by the reflection array; and

   in which each array comprises an optical emitter and an optical detector that operate through the transparent wall of the measuring chamber.

2. A liquid volume-flow meter according to claim 1 in which the emitter of the backscatter reflection array causes radiation to impinge upon an upper surface of liquid in the measuring chamber and the detector detects radiation reflected back from that surface.

3. A liquid volume-flow meter according to claim 1 in which the backscatter reflection array generates an output signal that varies continuously as the level of liquid in the pipe varies from the pipe being empty of liquid and the pipe being full of liquid.

4. A liquid volume-flow meter according to claim 1 in which the emitter of the backscatter reflection array is a narrow-angle emitter.

5. A liquid volume-flow meter according to claim 4 in which the emitter of the backscatter reflection array has an angle of emission of approximately 8°.

6. A liquid volume-flow meter according to claim 1 in which the detector of the backscatter reflection array is a wide-angle detector.

7. A liquid volume-flow meter according to claim 6 in which the detector of the backscatter reflection array has an angle of detection of approximately 120°.

8. A liquid volume-flow meter according to claim 1 in which the correction array or each of the correction arrays includes a multi-layer reflection array.

9. A liquid volume-flow meter according to claim 8 in which the emitter of the multi-layer reflection array directs radiation into a body of liquid in the measurement chamber and the detector detects radiation reflected from within the body of the liquid.

10. A liquid volume-flow meter according to claim 8 in which the multi-layer reflection array generates a signal that varies continuously as the depth of liquid within the chamber varies from zero to a fraction of the total depth of the chamber.

11. A liquid volume-flow meter according to claim 8 in which each of the emitter and the detector of the multi-layer reflection array are narrow-angle devices.

12. A liquid volume-flow meter according to claim 11 in which the angles of emission and detection of the emitter and detector of the -layer reflection array is approximately 8°.

13. A liquid volume-flow meter according to claim 1 in which the correction array or each of the correction arrays includes a transmission array.

14. A liquid volume-flow meter according to claim 13 in which the emitter of the transmission array directs radiation towards the detector of the transmission array.

15. A liquid volume-flow meter according to claim 14 in which the transmission array generates an output signal that is indicative of the presence or absence of liquid in the path of radiation between the emitter and the detector.

16. A liquid volume-flow meter according to claim 1 in which the velocity array comprises a plurality of optical detectors spaced along the flow path of the measuring chamber that can detect the presence or absence of liquid at spaced positions within the chamber.

17. A liquid volume-flow meter according to claim 16 in which outputs from the respective optical detectors are identified as being caused by successive arrival at the detectors of liquid, and the speed of that liquid is determined by measurement of the time taken for it to pass between the detectors and of knowledge of the distance between the detectors.

18. A liquid volume-flow meter according to claim 1 in which the output of each emitter is sampled by a respective calibration detector and the power delivered to the emitter is adjusted to cause the emitter to emit energy with a predetermined intensity.

19. A liquid volume-flow meter according to claim 1 in which the radiation emitted by some or all of the emitters is visible light.

20. A liquid volume-flow meter according to claim 1 in which the radiation emitted by some or all of the emitters is infra-red light.

21. A liquid volume-flow meter according to claim 1 further including a density detector for measuring the optical density of the liquid being measured.

22. A liquid volume-flow meter according to claim 21 in which an output from the density detector is used to modify the output of the optical area sensor.

23. A liquid volume-flow meter according to claim 1 further comprising a controller programmed to control the emitters and to analyse signals received from the receivers to generate an output indicative of volume-flow or volume-flow rate.

24. A milking installation including a volume-flow meter according to claim 1 for measuring the volume-flow of milk.

25. A method of measuring liquid volume-flow in a volume-flow meter comprising: at a plurality of measurement arrays

a. directing radiation from an optical emitter through a transparent wall into a measuring chamber and

b. detecting a proportion of that radiation emerging from the measuring chamber

i. at one array, by backscattering, measuring the depth of liquid in the measuring chamber to arrive at a first estimate if the area of the chamber occupied by flowing liquid; and

ii. at one or more other array making a further optical measurement to derive a corrected area measurement from the first estimate;

c. at an optical velocity array measuring the speed of liquid flowing within the measuring chamber; and

d. calculating volume flow from the velocity and the corrected area measurement.

26. A method according to claim 25 in which the further optical measurement includes one or more of a multi-layer scattering measurement and a transmission measurement.

27. A method according to claim 25 further comprising making a measurement of the optical density of the liquid and modifying the estimate of the area of liquid.

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